US008076598B2

(12) **United States Patent**
Billard et al.

(10) **Patent No.: US 8,076,598 B2**
(45) **Date of Patent: Dec. 13, 2011**

(54) **INTERLOCK SYSTEM AND METHOD FOR ROTARY DISCONNECT SWITCHES**

(75) Inventors: **Justin Thomas Billard**, Amston, CT (US); **Dean Arthur Robarge**, Southington, CT (US); **Robert Joseph Caggiano**, Wolcott, CT (US)

(73) Assignee: **General Electric Company**, Schenectady, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 524 days.

(21) Appl. No.: **12/211,491**

(22) Filed: **Sep. 16, 2008**

(65) **Prior Publication Data**

US 2010/0065406 A1 Mar. 18, 2010

(51) **Int. Cl.**
H01H 9/20 (2006.01)

(52) **U.S. Cl.** **200/50.06**

(58) **Field of Classification Search** 200/50.02, 200/50.03, 50.05, 50.06, 50.1–50.12, 566, 200/565

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,009,029	A *	11/1961	Bodenschatz et al.	.....	200/50.06
3,086,092	A *	4/1963	Poulton, Jr.	.....	200/50.06
3,970,808	A	7/1976	Gryctko et al.		
4,118,607	A	10/1978	Shaffer		
4,405,844	A	9/1983	Dizon et al.		
4,602,136	A *	7/1986	Deneke et al.	.....	200/50.06
4,806,710	A	2/1989	Kalvaitis et al.		
7,420,133	B2 *	9/2008	Farrow et al.	.....	200/50.12
2007/0029178	A1	2/2007	Mukharzi et al.		

* cited by examiner

Primary Examiner — Felix O Figueroa

(74) *Attorney, Agent, or Firm* — Cantor Colburn LLP

(57) **ABSTRACT**

Disclosed herein is an interlock system in combination with an enclosure, including: the enclosure having a base and a door that define an interior; a rotary handle attached to the door; a disconnect switch disposed in the interior of the enclosure and including a shaft extending toward an exterior of the enclosure in a direction toward the door; a first interlocking member attached to the door and extending toward an interior of the enclosure; and a second interlocking member attached to the shaft. The handle is configured to engage the shaft when the door is closed and rotate the shaft to move the disconnect switch between an on position and an off position. The second interlocking member is configured to engage and interlock with the first interlocking member when the door is closed and the disconnect switch is in the on position.

10 Claims, 16 Drawing Sheets

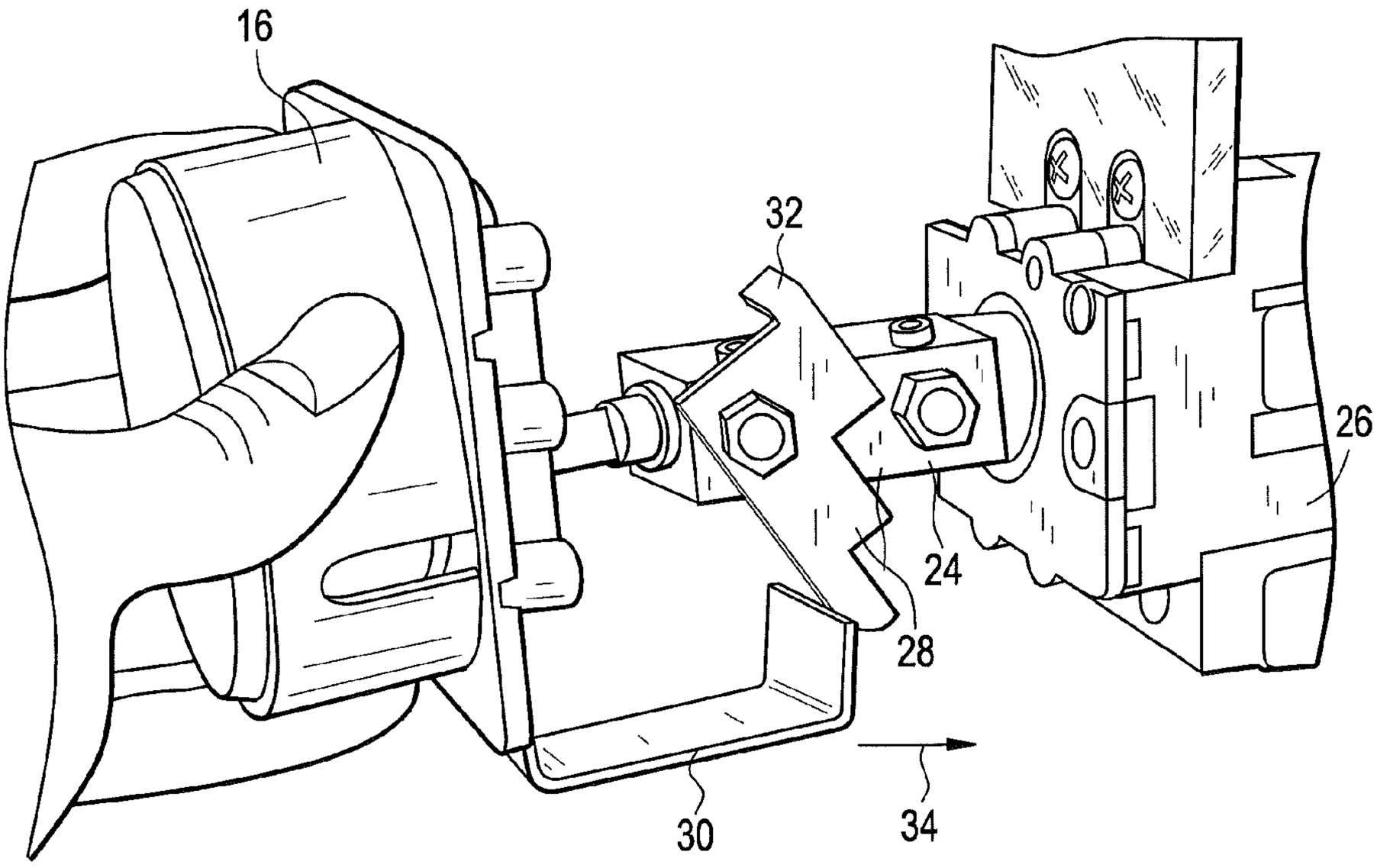


FIG. 1

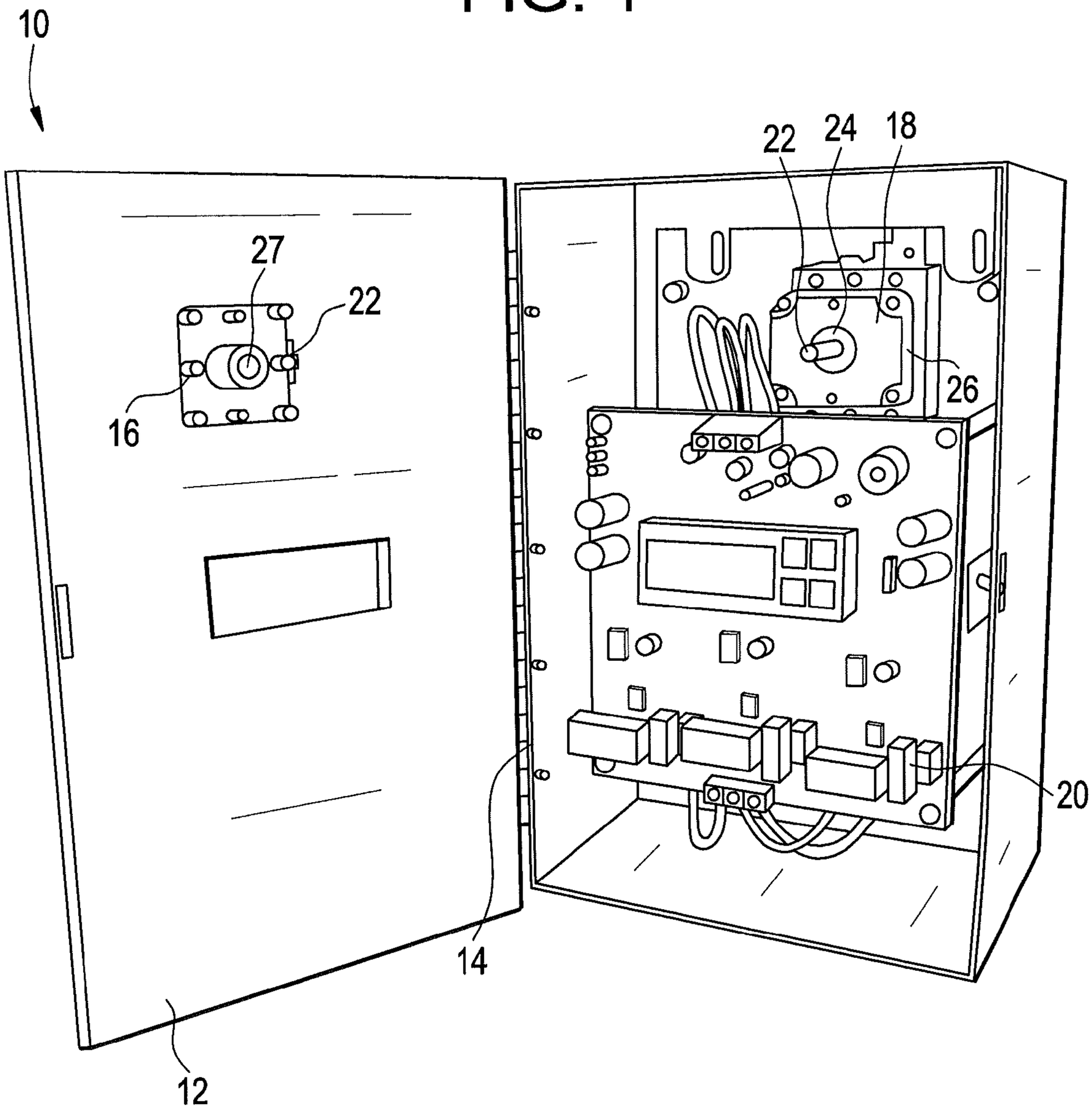


FIG. 2

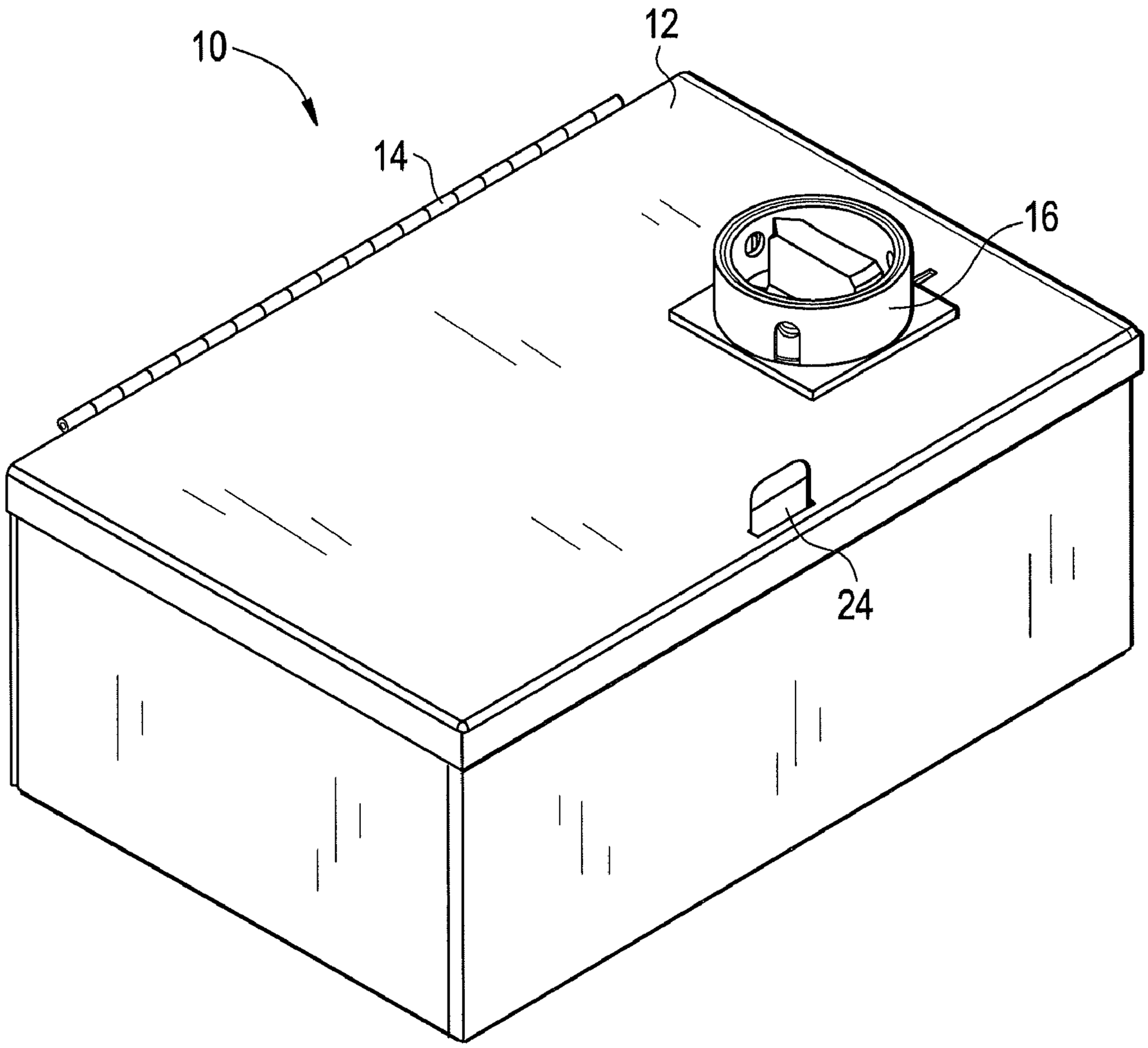


FIG. 3

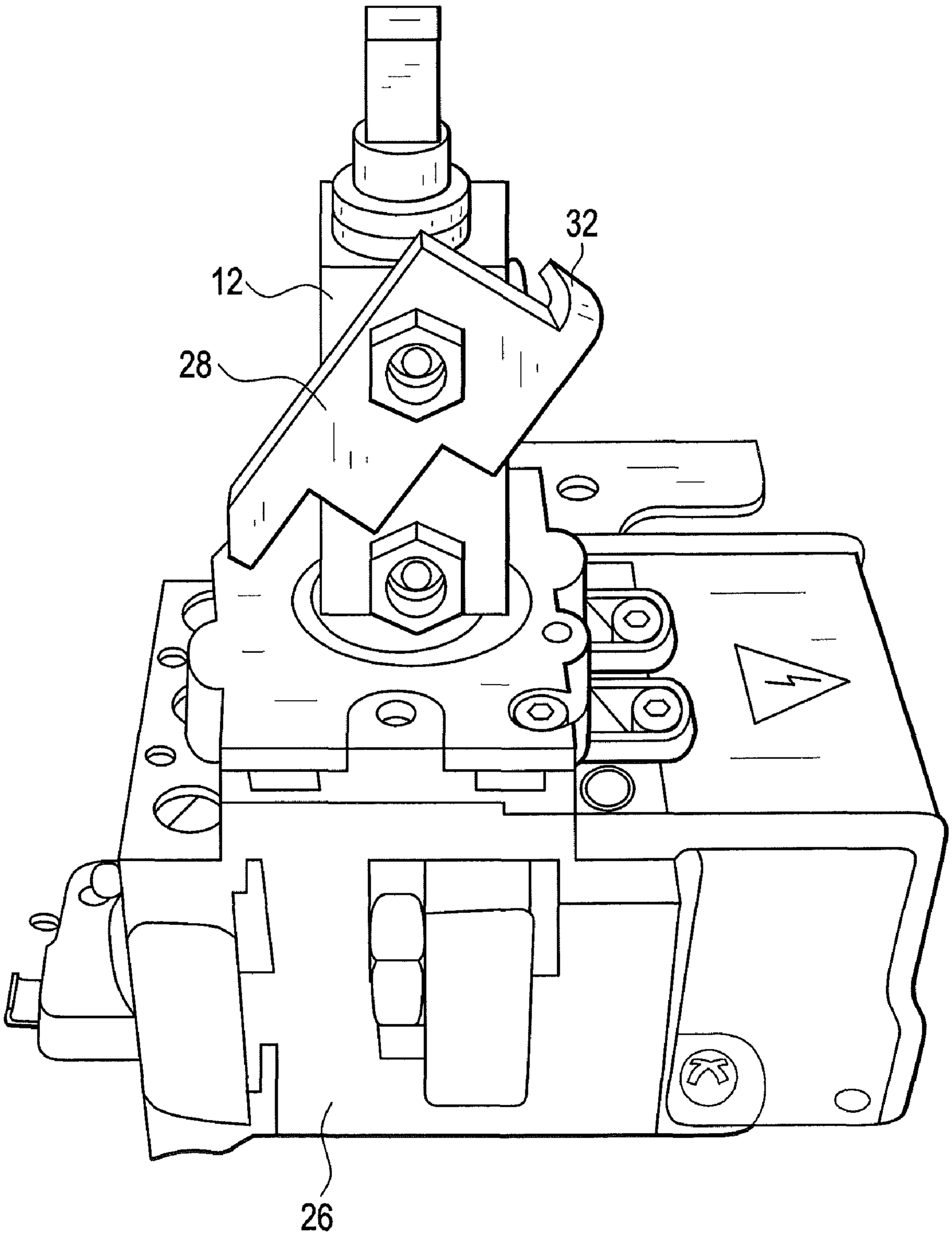


FIG. 4

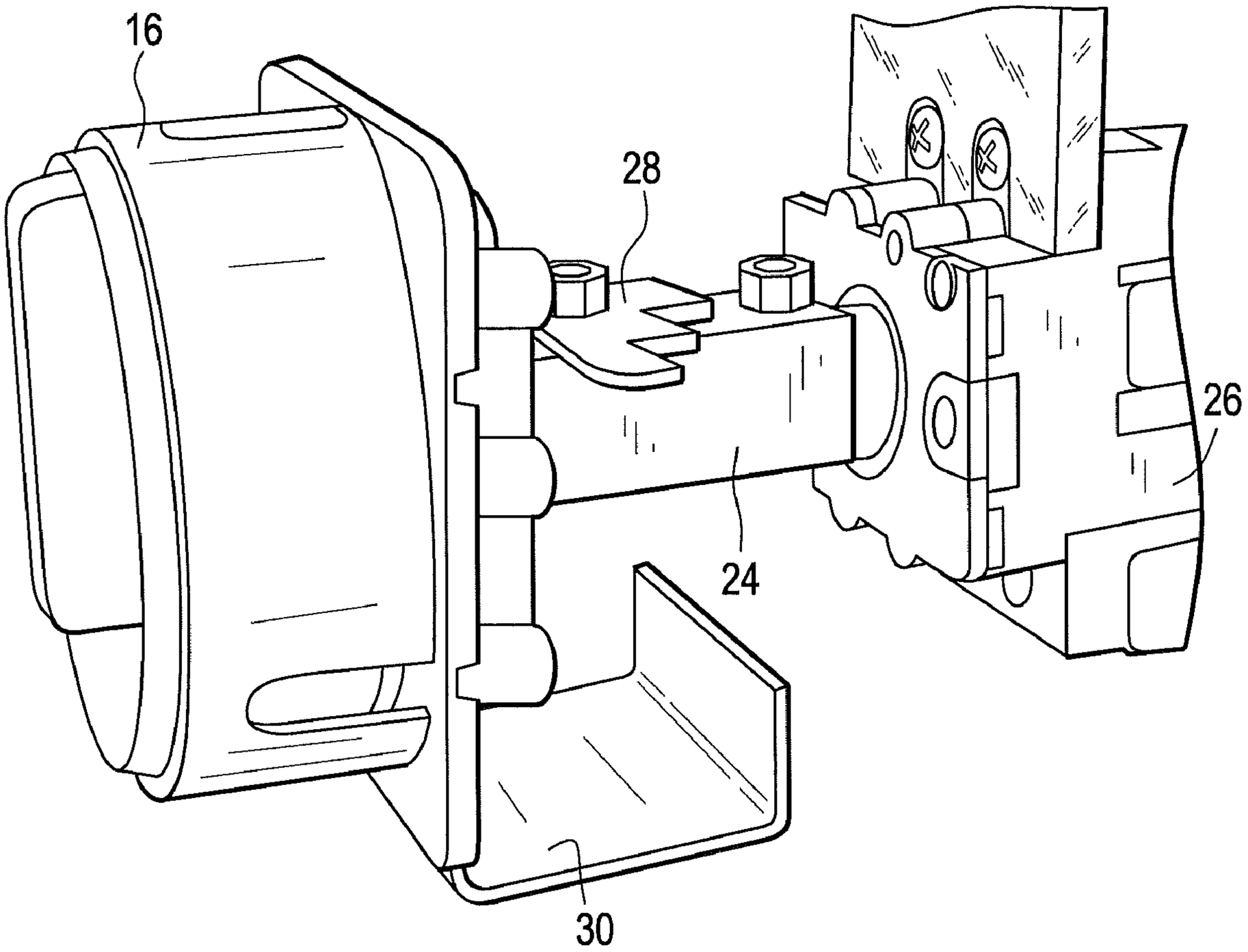


FIG. 5

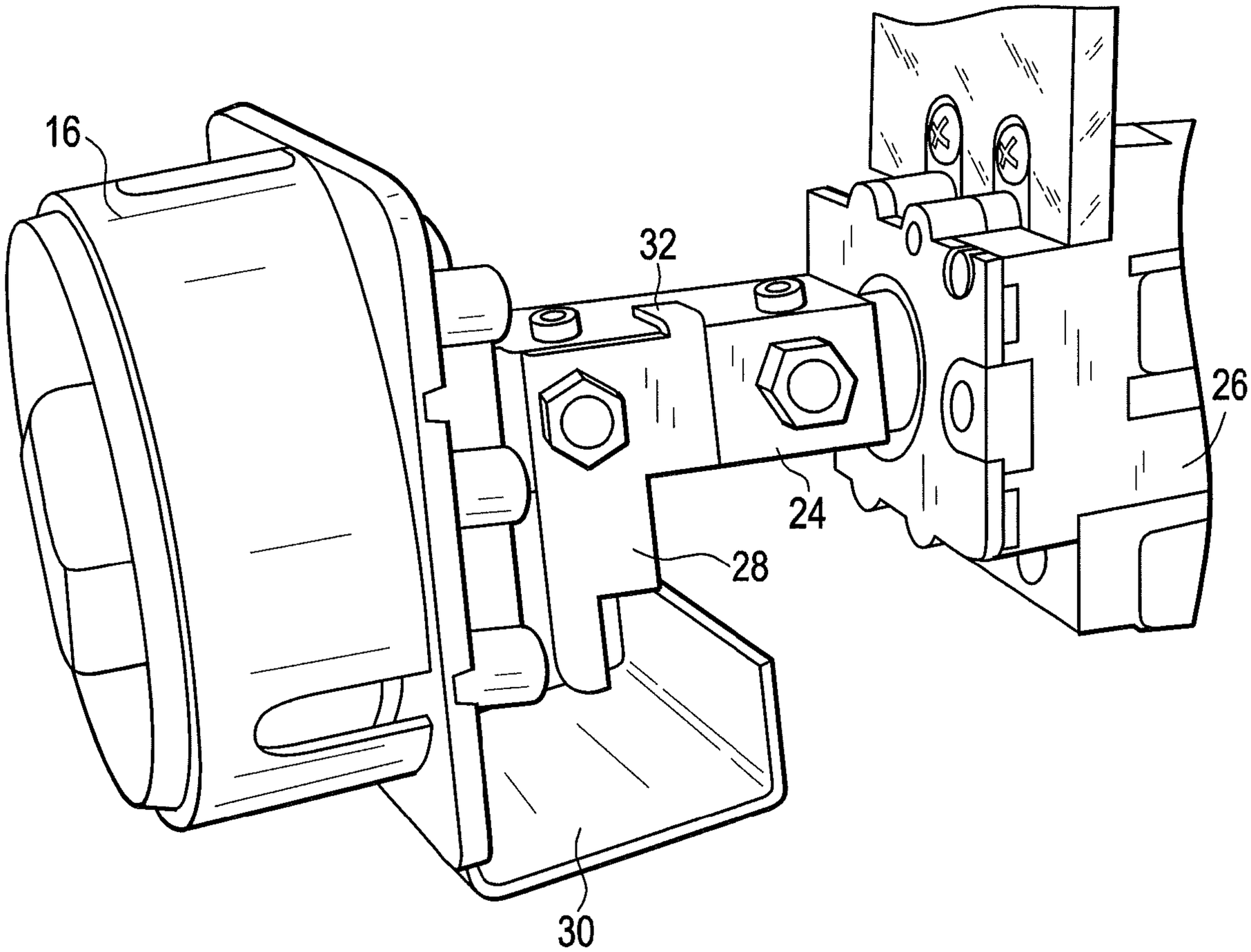


FIG. 6

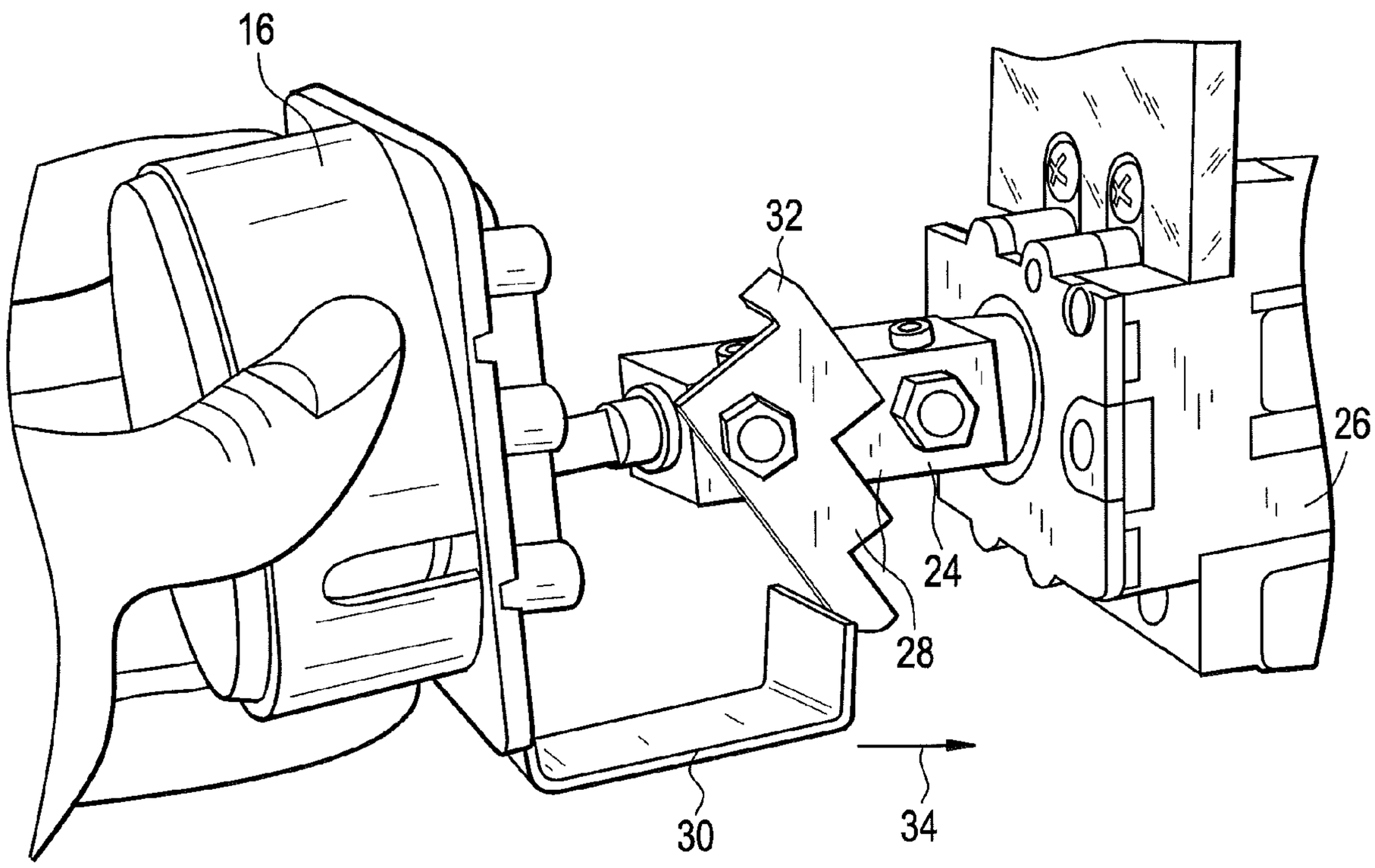


FIG. 7

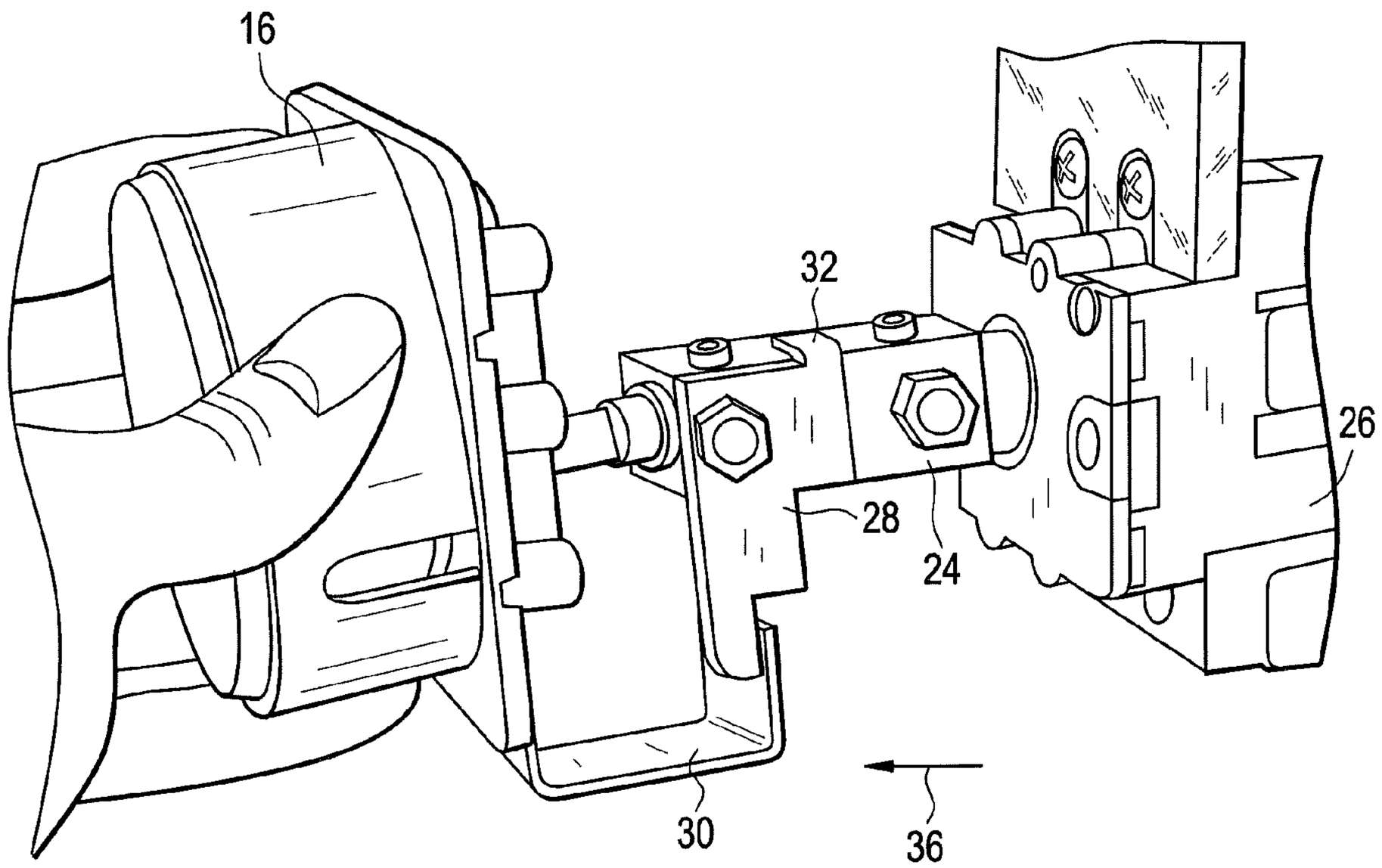


FIG. 8

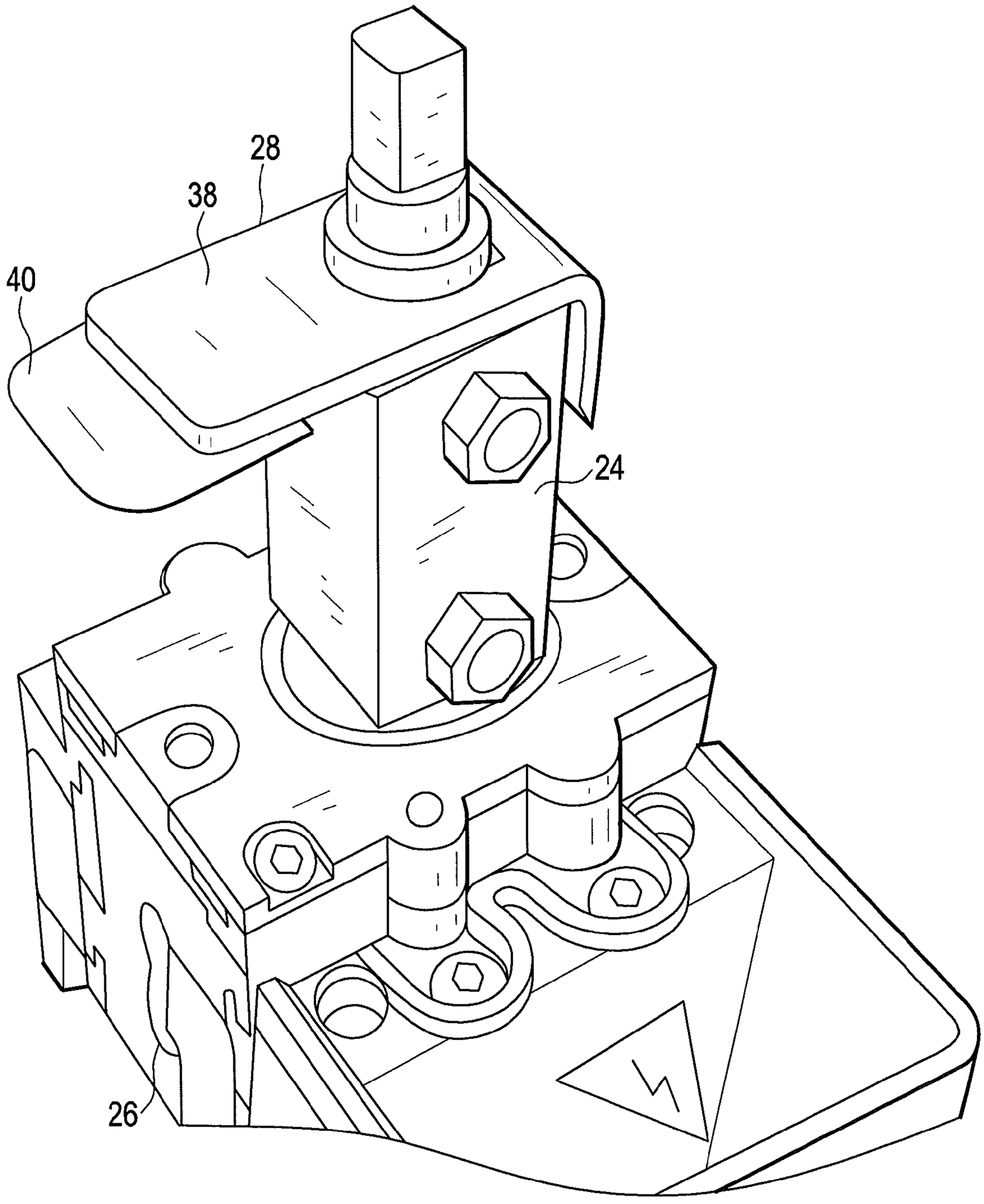


FIG. 9

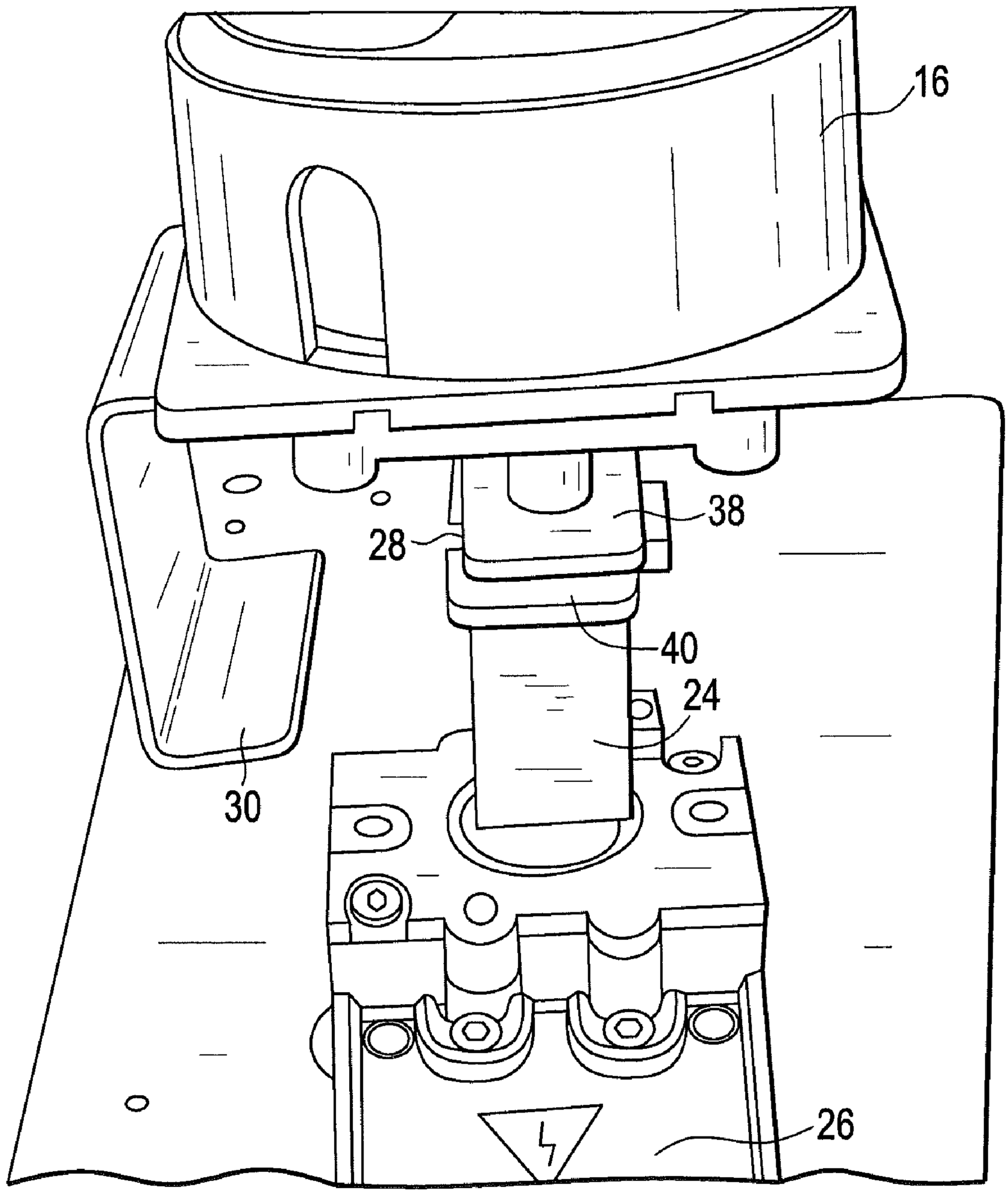


FIG. 10

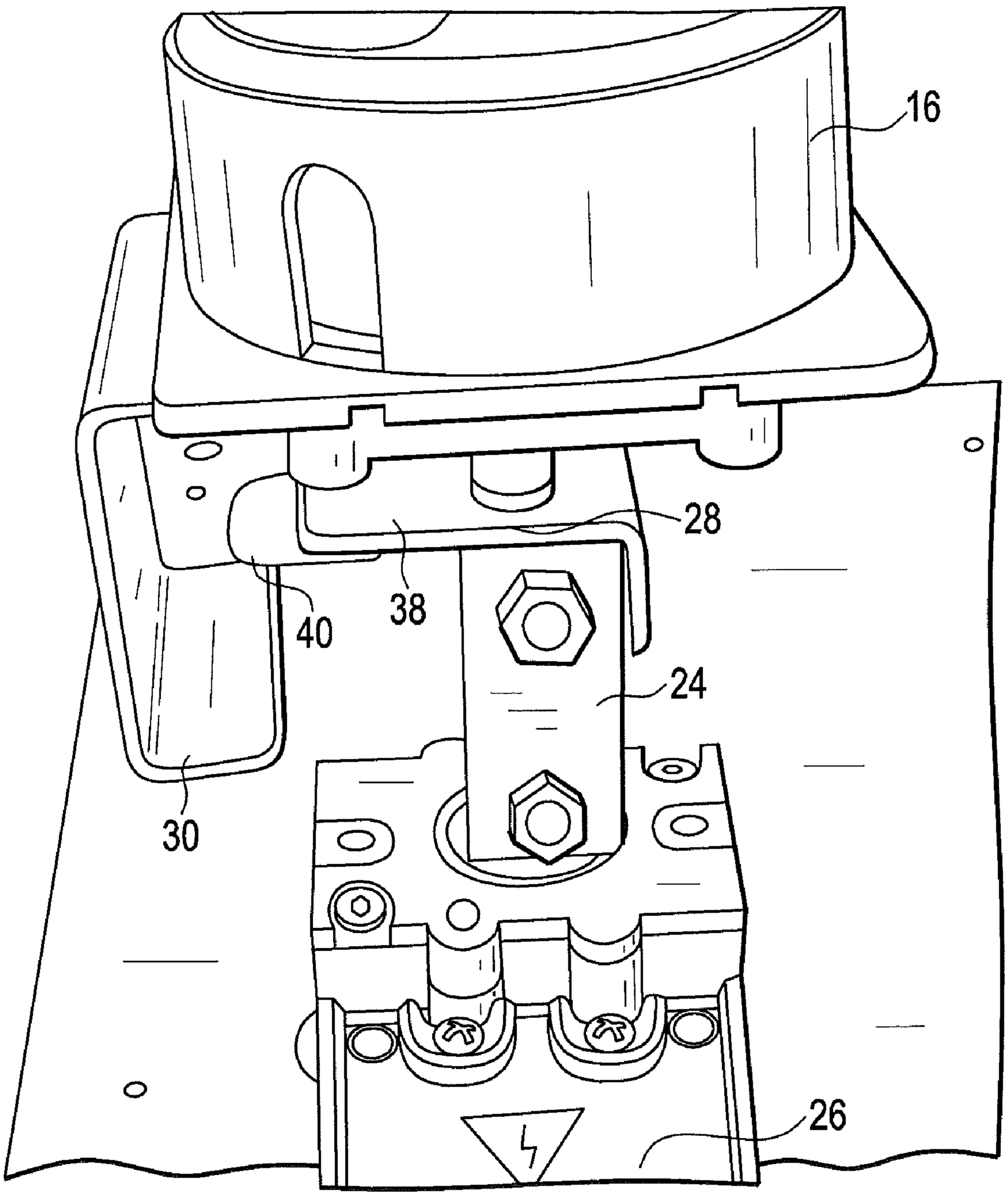


FIG. 11

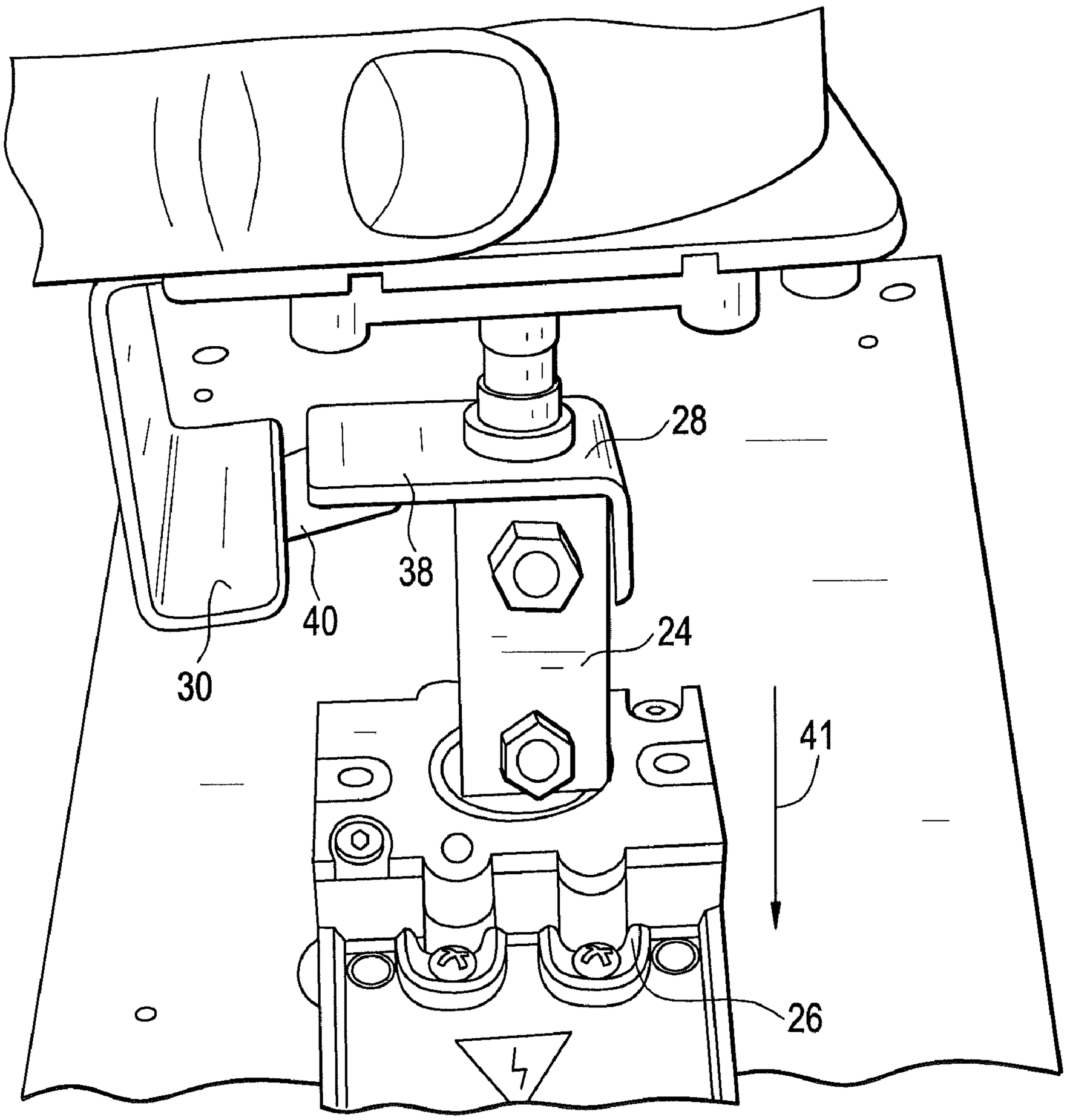


FIG. 12

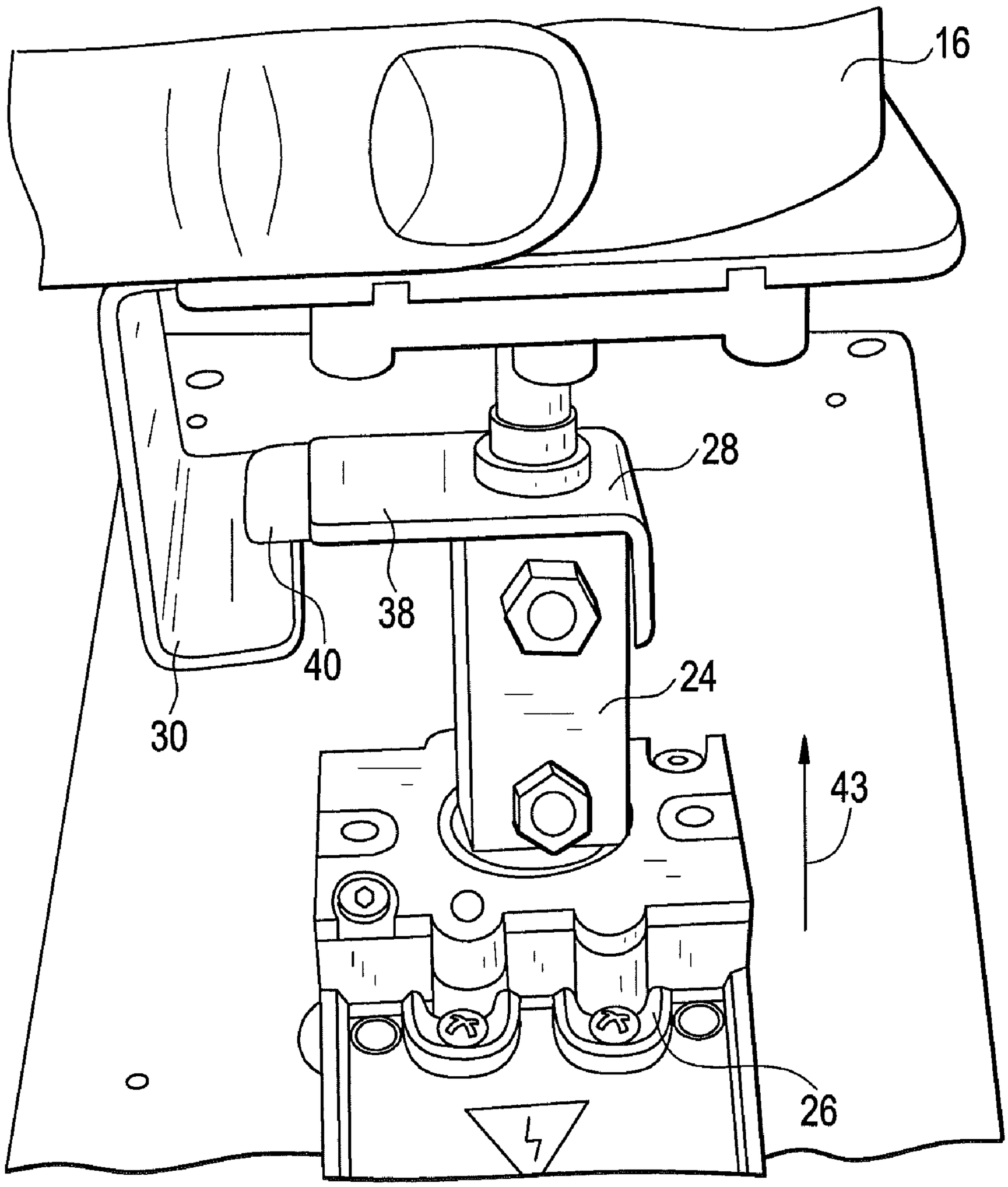


FIG. 13

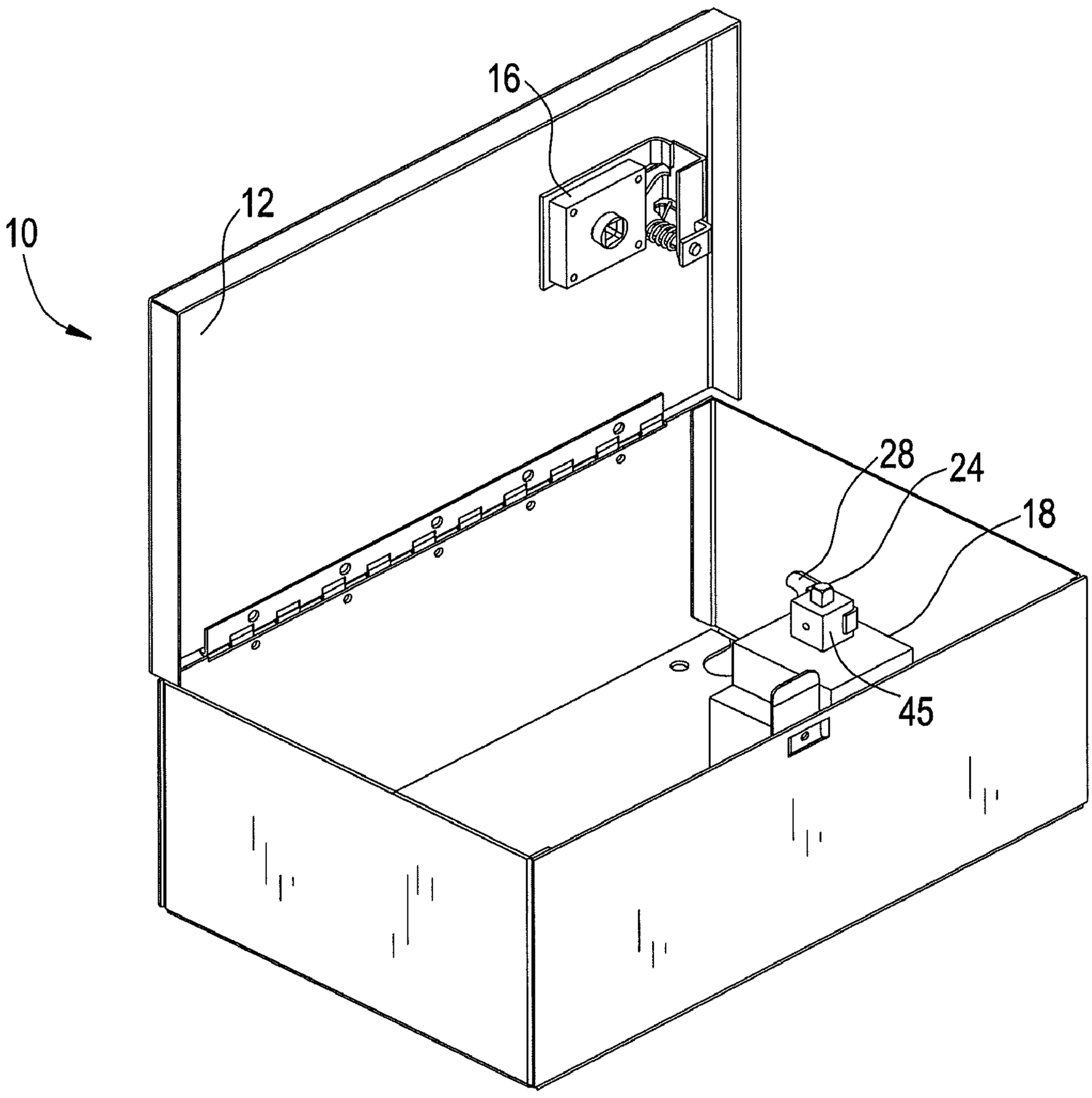


FIG. 14

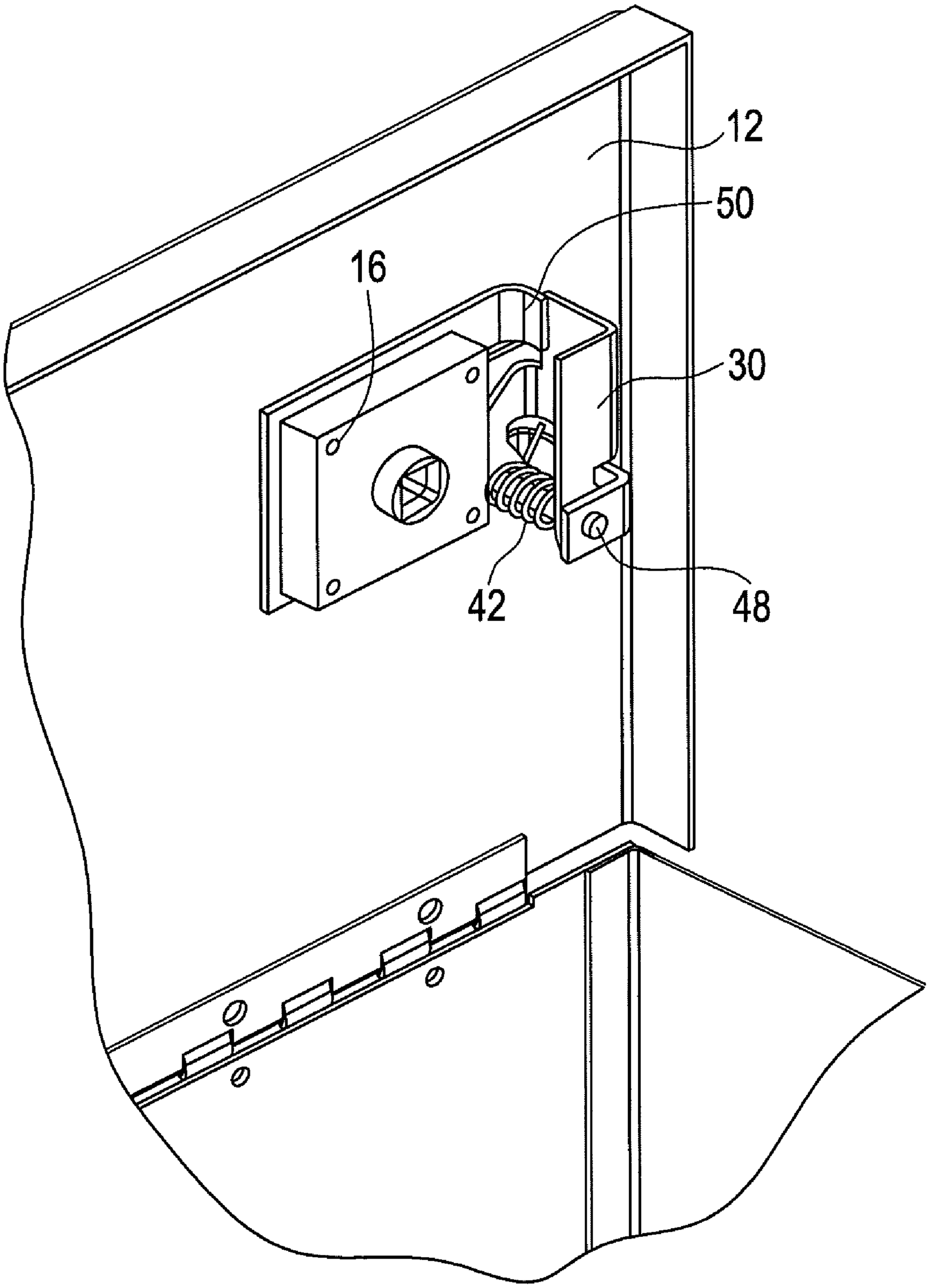


FIG. 15

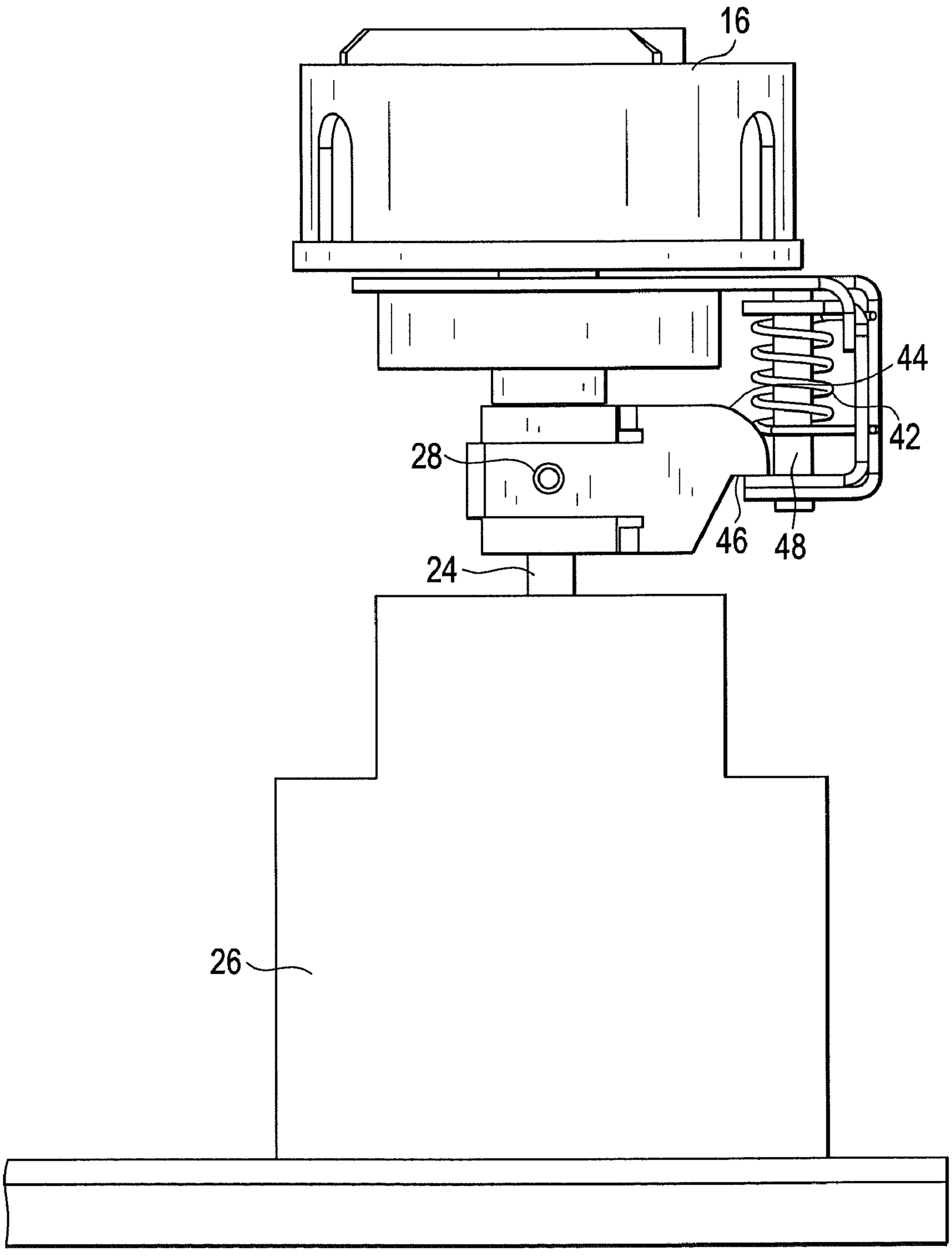
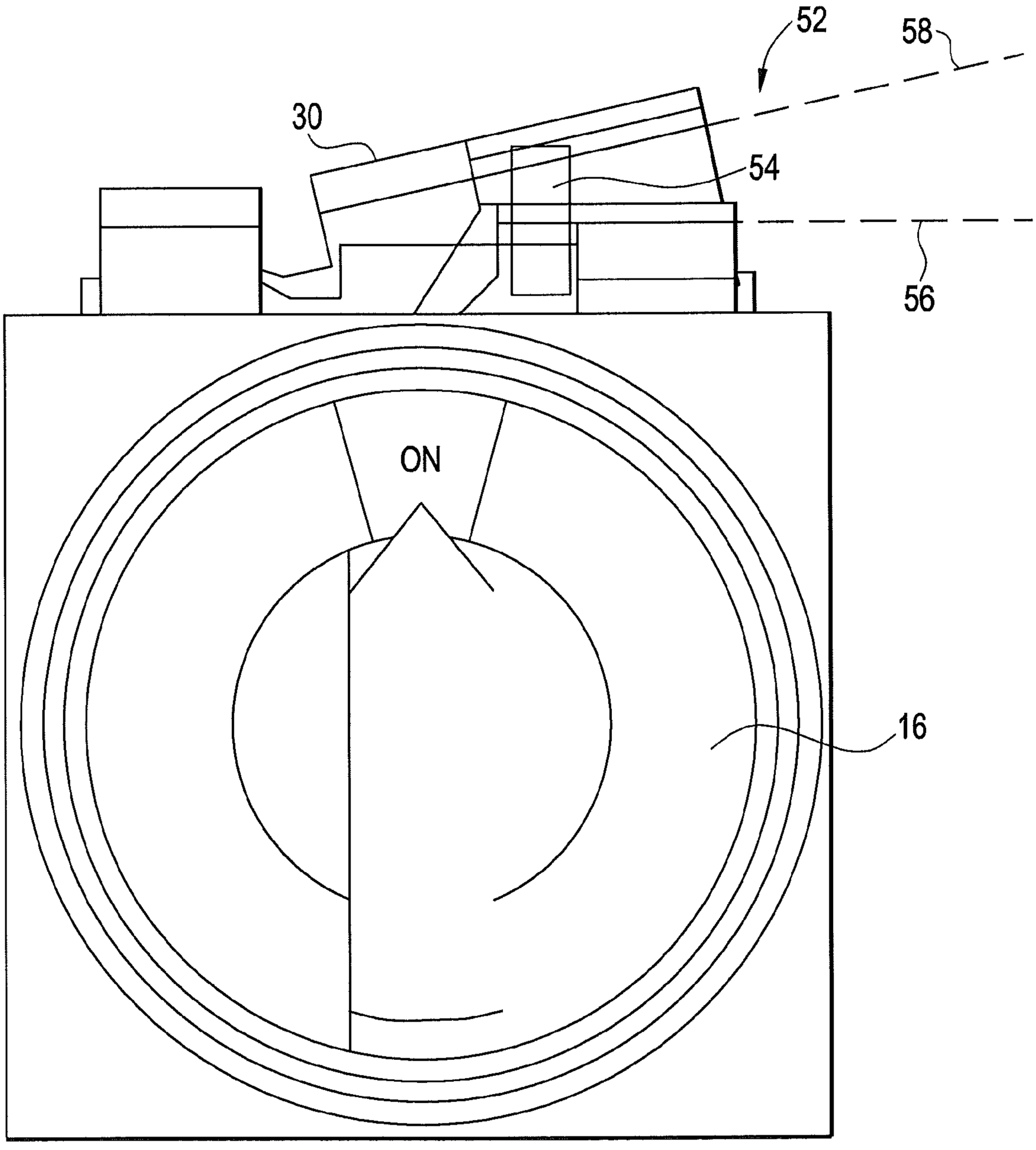


FIG. 16



INTERLOCK SYSTEM AND METHOD FOR ROTARY DISCONNECT SWITCHES

BACKGROUND OF THE INVENTION

The subject matter disclosed herein relates to electrical equipment and, more particularly, to interlock systems for electrical enclosures.

Conventional electrical distribution equipment such as circuit breakers are encased on housings to protect the equipment and avoid contact with the equipment when operating. Interlock devices are generally utilized to prevent undesired states of the enclosure, such as the opening of the enclosure when it is connected to an electrical source. Such devices are useful in preventing inadvertent opening, and for protecting users from gaining access unless the electrical power is disconnected. The industry may, therefore, be desirous of an improved system to interlock an electrical enclosure to prevent undesirable states of the enclosure.

BRIEF DESCRIPTION OF THE INVENTION

Disclosed herein is an interlock system in combination with an enclosure. The combination includes: an enclosure having a base and a door that define an interior, the door having an open position and a closed position; a rotary handle attached to the door of the enclosure; a disconnect switch disposed in the interior of the enclosure; a first interlocking member attached to the door and extending toward an interior of the enclosure; and a second interlocking member attached to the shaft. The disconnect switch includes a shaft extending toward an exterior of the enclosure in a direction toward the door, and the handle is configured to engage the shaft when the door is in the closed position and rotate the shaft to move the disconnect switch between an on position and an off position. The second interlocking member is configured to engage and interlock with the first interlocking member when the door is in the closed position and the disconnect switch is in the on position.

Further disclosed herein is a method of controlling a position of an enclosure. The method includes: attaching a rotary handle on a door of the enclosure; disposing a disconnect switch in an interior of the enclosure; attaching a first interlocking member extending toward an interior of the enclosure to the door; attaching a second interlocking member attached to the shaft; and moving the disconnect switch between the on position and the off position. The method also includes, responsive to the disconnect switch being in the on position, engaging the first interlocking member with the second interlocking member to i) prevent the door from being moved from the closed position toward the open position and ii) allow the door to be moved from the open position toward the closed position. The method further includes, responsive to the disconnect switch being in the off position, engaging the first interlocking member with the second interlocking member to allow the door to be moved between the open position and the closed position. The disconnect switch includes a shaft extending toward an exterior of the enclosure and the handle is configured to engage the shaft when the door is in the closed position and rotate the shaft to move the disconnect switch between an on position and an off position.

BRIEF DESCRIPTION OF THE DRAWINGS

The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

FIG. **1** depicts a perspective view of an enclosure including an interlock assembly in an open position, in accordance with an embodiment of the invention;

FIG. **2** depicts a perspective view of the enclosure of FIG. **1** in a closed position including a rotary handle in an off position;

FIG. **3** depicts a perspective view of an embodiment of the disconnect switch of FIG. **1**;

FIG. **4** depicts a perspective view of the disconnect switch of FIG. **3** with the housing removed and in an off position;

FIG. **5** depicts a perspective view of the disconnect switch of FIG. **3** with the housing removed and in an on position;

FIG. **6** depicts a perspective view of the disconnect switch of FIG. **5** with the housing removed and moving toward a closed position;

FIG. **7** depicts a perspective view of the disconnect switch of FIG. **5** with the housing removed and moving toward an open position;

FIG. **8** depicts a perspective view of another embodiment of the disconnect switch of FIG. **1**;

FIG. **9** depicts a perspective view of the disconnect switch of FIG. **8** with the housing removed and in an off position;

FIG. **10** depicts a perspective view of the disconnect switch of FIG. **8** with the housing removed and in an on position;

FIG. **11** depicts a perspective view of the disconnect switch of FIG. **10** with the housing removed and moving toward a closed position;

FIG. **12** depicts a perspective view of the disconnect switch of FIG. **10** with the housing removed and moving toward an open position;

FIG. **13** depicts a perspective view of the enclosure of FIG. **1** including another embodiment of the disconnect switch;

FIG. **14** depicts a magnified perspective view of components of the disconnect switch of FIG. **13** disposed on the housing door;

FIG. **15** depicts a magnified perspective view of components of the disconnect switch of FIG. **13** disposed inside the housing; and

FIG. **16** depicts a front view of a rotary handle of the disconnect switch of FIG. **13**.

DETAILED DESCRIPTION OF THE INVENTION

A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

Referring to FIGS. **1** and **2**, an electrical enclosure **10** including an embodiment of an interlock system disclosed herein is illustrated. The enclosure **10** includes a door **12** connected to a hinge **14**, a rotary handle **16** mounted on the door **12**, a rotary style disconnect switch **18** mounted on an interior surface of the enclosure **10**, and one or more electrical or mechanical devices **20**, such as a circuit breaker. An interlock assembly **22** is included and has components attached to the handle **16** and the switch **18**. Although the interlock assembly **22** is described in conjunction with the electrical enclosure **10**, the interlock assembly may be utilized with any enclosure having a hinged door and a rotary style switch.

The disconnect switch **18** includes an elongated member such as a shaft **24** that extends from a switch body **26** toward the door **12**. When the door **12** is closed, a recess **27** in the handle **16** engages the shaft **24**, allowing the shaft **24** to be rotated about its major axis between the on and off positions. In one embodiment, the shaft **24** is a contoured shaft and the recess **27** includes a female orifice that is configured to accept the contoured shaft **24**.

The interlock assembly is configured to allow the enclosure **10** to be opened and closed when the electrical disconnect switch **18** is in an "off" position. The interlock assembly is also configured so that the enclosure **10** can be closed when the electrical disconnect switch is in an "on" position, but the enclosure **10** cannot be opened unless a user takes specific action to defeat the interlock assembly **22**. FIG. **2** demonstrates the off position. As referred to herein, the "off" position is a position of the handle **16** and the disconnect switch **18** in which electrical contacts of the device **20** are disengaged and no electrical power is being supplied to the device **20**. In this position, the interlock assembly **22** is not engaged, thus allowing the door **12** to be readily opened, for example, by defeating a door interlock **24**.

As referred to herein, the "on" position is a position in which the handle **16** is rotated away from the off position. For example, the handle **16** is turned 90 degrees in a clockwise motion to switch the handle **16** to the "on" position. In this position, the disconnect switch is in a position such that the electrical contacts are engaged, and the interlock assembly is also engaged to prevent the door **12** from being opened.

Referring to FIG. **3**, an embodiment of the disconnect switch **18** includes the switch body **26**, the shaft **24** and an interlocking member **28** attached to the shaft **24**. The interlocking member is configured to engage another interlocking member **30** that is attached to the handle **16**. The interlocking members **28**, **30** are configured so that they are not engaged when the handle **16** is in the off position, but are engaged when the handle **16** is in the on position. In the on position, the interlocking members **28**, **30** are configured to allow the door to be moved in only one direction, that is from an open position toward a closed position.

In the off position, the interlocking member **28** is disposed at a location away from a path of movement of the interlocking member **30** when the door **12** is moved between the open and closed positions. That is, the interlocking member **28** is disposed a defined distance from the interlocking member **30** sufficient so that the interlocking members **28**, **30** do not contact one another when the door **12** is opened or closed.

In the on position, the interlocking member **28** is disposed at a location that intersects a path of movement of the interlocking member **30** when the door **12** is moved between the open and closed positions. That is, the interlocking member **28** is disposed so that the interlocking members **28**, **30** come in contact with one another when the door **12** is opened or closed.

In one embodiment, the interlocking member is a "C-shaped" bracket having a first portion attached to the door **12**, a second portion extending away from the door **12**, and a third portion extending in a direction generally parallel to a plane defined by an interior surface of the door **12**. If the disconnect switch is on, as the door is open or closed, the C-shaped bracket **30** that is attached to the inside of the door interferes with the interlocking member **28** attached to the shaft **24**. The C-shaped bracket **30** and the door also have an access hole through them allowing the interlock to be defeated. The interlocking member **28** is configured so that interference due to the interlocking member **28** intersecting a path of the bracket **30** as the door is being opened cannot be overcome, but the interference as the door is being closed can be overcome. This ensures that the door **12** can only be closed when the switch assembly **22** is in the on position but cannot be opened. If the switch assembly **22** is off, no interference occurs, and the door **12** can be opened or closed.

In one embodiment, the interlocking member **28** is a rotating cantilever beam **28** rotatably attached to the shaft **24**. The beam **28** is attached to the shaft **24** so that the beam **28** can rotate about an axis that is orthogonal to the shaft axis of rotation. The beam **28** includes a mechanical stop **32** to prevent rotation of the beam **28** away from the switch body **26** and toward the door **12**. In this embodiment, the interlocking member **30** is a bracket that is fixedly attached to the door **12** and/or the handle **16**. The beam **28** is allowed to fall due to gravity to a default position when the shaft **24** is in the on position, in which the beam **28** is located in a path of movement of the bracket **30**.

FIG. **3** shows the interlocking member **28** in a disengaged position in which the interlocking member **28** is rotated away from the default position. In this embodiment, the interlocking member is shown being biased toward the default position by gravity. In other embodiments, the interlocking member **28** is attached to a biasing member such as a spring that holds the interlocking member **28** in tension toward the default position.

Referring to FIG. **4**, the interlock assembly is shown in the off position. In this position, the beam **28** is located at a position where it would not engage the bracket **30** regardless of the position of the door **12**.

Referring to FIG. **5**, in the on position, the beam **28** is rotated about the shaft axis so that the shaft **28** contacts the bracket **30** when the door **12** is moved between the open and closed positions. In this position, the beam **28** is configured to allow the door **12** to be closed but prevents the door from being moved from the closed to open position. A distance "d" is determined between a latch surface of the interlocking member **28** and the locking surface of the C-shaped bracket **30**. The distance "d" is great enough to allow the interlock assembly **22** to be defeated yet still not allow the door **12** to be opened enough to allow access to live electrical components.

Referring to FIG. **6**, in the instance that the interlock assembly **22** is in the on position, and the door **12** is moved in a direction **34** toward the closed position, the bracket **30** contacts the beam **28** and causes the beam **28** to rotate about the orthogonal axis. In this manner, the beam **28** allows the bracket **30** and the door **12** to be moved to the closed position.

Referring to FIG. **7**, in the instance that the interlock assembly **22** is in the on position and the door **12** moved in a direction **36** away from the closed position, the bracket **30** also contacts the beam **28**. However, in this instance, the mechanical stop **32** prevents the beam from rotating further and the beam **28** engages the bracket **30** to prevent the door from being opened. Accordingly, if the switch assembly **22** is on, the interlocking member **28** will rotate out of the path of the bracket **30** as the door **12** is closed but will not rotate out of the path of the bracket **30** as the door **12** is opened. This again ensures that if the switch assembly **22** is on, the user can close the door **12** but not open it.

Referring to FIG. **8**, another embodiment of the interlocking assembly **22** is shown. In this embodiment, the interlocking member **28** includes two overlapping component members **38** and **40**. The first component member **38** is a relatively rigid cantilever beam extending from the shaft **28** in a direction orthogonal to the shaft axis of rotation. The second component member **40** is a relatively flexible, resilient member attached to the first component member **38**. A portion of the flexible member **40** extends in the orthogonal direction beyond an end of the first member **38**, and is configured to bend in a direction toward the closed position and stay rigid in a direction toward the open position. Thus, when the switch **18** is in the on position, the bracket **30** bends the flexible cantilever beam **40** out of the path of the bracket **30** as the door **12** is closed, but if the door is moved from the closed to the open position, the bracket **30** is unable to bend the flexible beam **40** and the door **12** is prevented from opening.

For example, the rigid member **38** is a generally flat, forming surfaces that generally face in a direction that is parallel to the axis of rotation of the shaft **24**. The flexible member **40** is also generally flat and is attached to the rigid member **40** in a surface facing the interior of the housing **10**.

In one embodiment, the first component member is made of a rigid material such as aluminum. The second component member is made of a flexible, resilient material such as spring steel.

Referring to FIG. **9**, the interlock assembly **22** is shown in the off position. As shown, the interlocking member **28** is positioned away from a path of the bracket **30**, thus allowing the door **12** to be opened and closed without interference. Referring to FIG. **10**, when the interlock assembly **22** is in the on position, a portion of the flexible member **40** is in the path of the bracket **30**.

Referring to FIG. **11**, if the interlock assembly is in the on position and the door **12** is moved in a direction **41** from the open position to the closed position, the bracket **30** causes the flexible member **40** to bend and allow the door **12** to be closed. For example, the flexible member **40** bends toward the interior of the enclosure **10** and thus allows the bracket **30** to over come any interference introduced by the flexible member **40**.

Referring to FIG. **12**, if the interlock assembly **22** is in the on position and the door **12** is moved in a direction **43** from the closed position toward the open position, the flexible member **40** will not bend and thus the bracket **30** is prevented from further movement. For example, due to the position of the flexible member **40** in the surface of the rigid member **38**, the flexible member **40** is prevented from bending toward the exterior by the rigid member **38**. A distance "d" is determined between a latch surface of the flexible member **40** and the locking surface of the C-shaped bracket **30**. The distance "d" is great enough to allow the interlock assembly **22** to be defeated yet still not allow the door **12** to be opened enough to allow access to live electrical components.

Referring to FIGS. **13-15**, another embodiment of the interlocking assembly **22** is shown. In this embodiment, the interlocking assembly **22** includes the latch **28** attached to the shaft **24** and having a cammed surface, and the bracket **30** is a hinged bracket attached to the inside of the door **12** that includes a biasing device **42** such as a torsion spring. The cammed surface on the latch **28** ensures that if the door **12** is closed while the switch is in the on position, then the latch **28** will force the bracket to hinge away from the latch **28**, but if a user attempts to open the door **12** while the switch is in the on position, the latch **28** will not cause the bracket **30** to hinge away from the latch **28**. When the switch is in the off position, the latch is rotated away from the path of the bracket **30**, allowing the door **12** to be opened or closed without any additional action required by the user. In one embodiment, the shaft **28** is mounted on a spacer block **45** or other structure to control the height and location of the shaft **28**.

The shaft **28** includes opposite surfaces **44** and **46**. The first surface **44** is a cammed surface generally facing the exterior of the housing **10**, and the second surface **46** includes a generally flat latching surface opposite the first surface.

The latching surface **46**, when the switching assembly is in the on position, engages the bracket **30** to prevent the door **12** from being moved from the closed position to the open position. When the door **12** is moved from the open position toward the closed position, the cammed surface **44** interferes with the bracket **30** causing the bracket **30** to rotate about a pivot pin **48** or other pivot point and move away from the latch **28**. A biasing member such as the torsion spring **42** causes the bracket **30** to move toward a rest position. In one embodiment, the rest position is provided by a mechanical stop **50** such as a stop tab attached to the door **12**.

Referring to FIG. **16**, the handle includes a interlock defeating device **52** that includes the bracket **30** attached to the pivot pin **48** and the torsion spring **42**, and a defeat slot **54**. The defeat slot **54** is an opening in the handle **12** and/or the door **12** that is configured to allow a probe or other device to be inserted into the handle **12**. The inserted probe is used to exert a force on the bracket **30** to overcome the torsion spring **42** and rotate the bracket **30** away from the latch **28** when the door is the closed position and the switch assembly **22** is in the on position. In this way, the interlock assembly **22** can be defeated to allow a user to open the door **12** even when the interlock assembly is in the on position. The slot **54** allows the bracket **30** to be rotated between a first position **56**, in which the latch **28** and the bracket **30** are disengaged, and a second position **58**, in which the latch **28** and the bracket **30** are disengaged.

After the interlocking assembly **22** has been defeated, the door **12** may be closed with an automatic reset device such as the torsion spring **42**, which causes the bracket **30** to rotate toward the rest position in which the bracket is held against the lever stop tab **50**.

The systems and methods described herein provide numerous advantages over prior art systems. The device and method provide an effective interlock for rotary style handles to enhance user safety. The device and method ensuring that unless a user takes deliberate and specific action to defeat the interlock, such as by affirmatively engaging a defeat mechanism, the user will not be able to open the enclosure unless the disconnect switch is off. This protects the user from gaining access to inside of the electrical enclosure unless the power is disconnected using the disconnect switch or the user takes deliberate action to defeat the interlock. Furthermore, the device and method ensure that the user can close the electrical enclosure door whether the disconnect switch is on or off.

Furthermore, the systems and methods provide a simple and affordable interlock mechanism for use with a rotary handle, in contrast to lever type handles that utilize a lever that rotates up or down around a fixed point at one end of the lever. The systems and methods may be used with a disconnect switch in which the user instead rotates a rotary handle clockwise and counter-clockwise. The systems and methods allow for the use of a door-mounted rotary disconnect switch and therefore leads to a reduction in cost, complexity, and size while also making the product more visually appealing.

In general, this written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of exemplary embodiments of the invention if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

What is claimed is:

1. An interlock system in combination with an enclosure, the combination comprising:

an enclosure having a base and a door that define an interior, the door having an open position and a closed position;

a rotary handle attached to the door of the enclosure;

a disconnect switch disposed in the interior of the enclosure, the disconnect switch including a shaft extending

toward an exterior of the enclosure in a direction toward the door, the handle configured to engage the shaft when the door is in the closed position and rotate the shaft to move the shaft of the disconnect switch between an on position and an off position;

a first interlocking member attached to the door and extending toward an interior of the enclosure; and

a second interlocking member attached to the shaft, the second interlocking member being configured to engage and interlock with the first interlocking member when the door is in the closed position and the disconnect switch is in the on position, wherein the second interlocking member comprises a cantilever beam rotatably attached to the shaft and configured to rotate about an axis that is orthogonal to a rotational axis of the shaft.

2. The combination of claim **1**, further comprising:

an electrical device disposed within the enclosure;

wherein the disconnect switch is configured to engage the electrical device to electrically connect the electrical device to an electric power source when the disconnect switch is disposed in the on position; and

wherein the disconnect switch is configured to disengage the electrical device to electrically disconnect the electrical device from the electric power source when the disconnect switch is disposed in the off position.

3. The combination of claim **2**, wherein the electrical device comprises a circuit breaker.

4. The combination of claim **1**, wherein the first interlocking member comprises a "C"-shaped bracket.

5. The combination of claim **1**, wherein the second interlocking member is configured to rotate about a shaft rotational axis between the on position and the off position, the second interlocking member is disposed at a first location in the on position and a second location in the off position, the first location is intersected by the first interlocking member when the door is moved between the open position and the closed position, and the second location is not intersected by the first interlocking member when the door is moved between the open position and the closed position.

6. The combination of claim **1**, wherein the second interlocking member comprises a mechanical stop to prevent rotation of the shaft toward the door.

7. A method of controlling a position of an enclosure, the method comprising:

attaching a rotary handle on a door of the enclosure;

disposing a disconnect switch in an interior of the enclosure, the disconnect switch including a shaft extending toward an exterior of the enclosure, the handle configured to engage the shaft when the door is in the closed position and rotate the shaft to move the shaft of the disconnect switch between an on position and an off position;

attaching a first interlocking member to the door, the first interlocking member extending toward an interior of the enclosure;

attaching a second interlocking member attached to the shaft;

moving the shaft of the disconnect switch between the on position and the off position;

responsive to the disconnect switch being in the on position, engaging the first interlocking member with the second interlocking member to i) prevent the door from being moved from the closed position toward the open position and ii) allow the door to be moved from the open position toward the closed position; and

responsive to the disconnect switch being in the off position, engaging the first interlocking member with the second interlocking member to allow the door to be moved between the open position and the closed position, wherein the second interlocking member is a cantilever beam rotatably attached to the shaft and configured to rotate about an axis that is orthogonal to a rotational axis of the shaft.

8. The method of claim **7**, wherein the disconnect switch engages an electrical device in the enclosure to electrically connect the device to an electric power source in the on position, and the disconnect switch disengages the device to disconnect the device from the power source in the off position.

9. The method of claim **7**, wherein moving the shaft of the disconnect switch includes rotating the shaft and the second interlocking member about a shaft rotational axis between the on position and the off position, the second interlocking member intersects a path of the first interlocking member in the on position, and the second interlocking member is located away from the path in the off position.

10. The method of claim **7**, wherein the second interlocking member includes a mechanical stop to prevent rotation of the shaft toward the door.

* * * * *